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USDA Forest Service
General Technical Report INT-17, 1974
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INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
Forest Service
U.S. Department of Agriculture
Ogden, Utah 84401
Roger R. Bay, Director

THE AUTHORS

ALLEN K. DAHLGREEN graduated with a B.S. degree in Forest Management from the University of Washington in 1950. He worked in Timber Management positions on the Wenatchee National Forest in Washington and the Ashley National Forest in Utah. He served as a District Ranger on the Payette National Forest in Idaho, and in 1959 he was assigned responsibility for Silvicultural Practices programs on that Forest. In 1966, he transferred to the Silvicultural Practices Group in the Intermountain Regional Office in Ogden, where he is responsible for reforestation, logging slash treatment, and erosion control on timber sale programs.

RUSSELL A. RYKER is a Research Silviculturist for the Intermountain Station at Boise, Idaho. He received his B.S. (Forestry) degree in 1954 and M.S. (Forestry) degree in 1962 from the University of Missouri. From 1956 to 1963, he conducted research in the silviculture of central hardwoods for the Central States Station. From 1963 to 1967, he was with the silviculture project at Moscow, Idaho.

DAVID L. JOHNSON is Regional Silviculturist in the Alaska Region of the Forest Service. He received a bachelor of science degree in Agriculture with a major in Forest Management from Michigan State in 1950. After 10 years as Supervisor with Potlatch Forests, Inc., Dave entered the Forest Service in 1961. He worked on three different Ranger Districts on the Payette Forest before joining the Branch of Timber Management in the Payette Supervisor's Office. He has participated in slash disposal, erosion control, and reforestation and timber stand improvement programs.

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ABSTRACT

Good survival and growth of planted seedlings have been experienced in the Intermountain Region, USDA Forest Service, when proper snow cache planning, construction, and related tree handling techniques are practiced. General snow storage and handling requirements are described, and planning and construction details are provided for two types of snow caches that have been used successfully for several years by the Payette National Forest in west-central Idaho. The pit snow cache has been the prescribed seedling storage method for the Intermountain Region since 1970. The culvert snow cache also is a field-proven system. The report includes recommendations applicable to both systems and others for proper pre- and post-storage care of seedlings.

INTRODUCTION

Successful reforestation by tree planting requires meticulous planning and care at each step. Proper attention to the storage and handling portion of the process will not insure success if all other steps are not equally well done. However, seedling storage and handling often are slighted in reforestation programs, being relegated to untrained persons using inadequately planned facilities. Improvements in this phase of the process, therefore, are critical to improved programs.

The techniques described here have been an important part of most successful reforestation programs in the Intermountain Region in recent years. Numerous instances have been recorded in the Region where trees stored in snow caches for 60 to 90 days or more, and handled as described, have responded with first-year survival of 90 percent or more and good initial growth.

In 1973, more than 95 percent of the 6.9 million trees planted in the Region were stored in snow caches. The average first-year survival of all trees planted was 88 percent. Species included ponderosa pine, Jeffrey pine, lodgepole pine, Douglas-fir, western larch, and Engelmann spruce.

Snow caches have been used to store tree seedlings in the Intermountain Region and elsewhere for many years. Results have varied according to snow cache design, or lack of it, and pre- and post-storage tree handling. A recent study[1] indicated that properly constructed snow storage facilities provide a good temperature regimen for planting stock over extended periods. Temperatures measured within the root mass of packaged trees stored in two types of snow caches were actually lower, and fluctuated less, than those measured in similarly packaged trees stored in the cooler at Lucky Peak Nursery.

This report describes two field-proven snow cache systems, and tree handling procedures compatible with them. The first type (the pit snow cache) is essentially a pit dug in a suitable snowbank, filled with trees, covered over with snow, and insulated. Pit caches have been used successfully for many years on the Payette National Forest in Idaho, and elsewhere in the Intermountain Region. The second type (the culvert snow cache), developed by Dave Johnson for the Payette National Forest, utilizes one or more large culverts placed on site in the fall and allowed to snow in. Early the next spring, trees are placed in the culverts upon arrival from the nursery, and the openings are resealed with snow. This technique has also proven successful with certain types of seedling packages, and where snowfall is adequate.

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[1]R. A. Ryker, A. K. Dahlgreen, D. Johnson, and F. E. Morby. Snow cache temperatures suitable for storage of conifer nursery stock. USDA For. Serv. Res. Note INT-181, 7 p., illus. 1974.

STORAGE AND HANDLING REQUIREMENTS

Experience in the Intermountain Region indicates that a satisfactory seedling storage system must assure that temperatures within the mass of trees being stored are reduced to about 33° to 34°F in a short time, and maintained at that level for 100 days or more. The trees should not be disturbed until just before planting, and injurious influences such as temperature and humidity fluctuations and fungi must be excluded or suppressed by adequate snow barriers. Trees should not be subjected to serious stress while in transit from the nursery or after removal from storage.

Properly located, designed, and protected snow caches meet these storage requirements. Adherence to the handling techniques described will minimize stress and "shock" during transportation and preplanting handling.

CACHE LOCATION AND PLANNING

The general location, timing, and coordination considerations vital to good storage management are equally applicable to pit and culvert caches.

The exact snow cache location should be selected in the fall, particularly if a large volume of trees will be stored. The site should be convenient for the transportation to be used, and adequate snow must be available when the trees arrive. A preferred location is a level area in open shade on a gentle northerly slope. However, the north side of a stand of tall trees, or the north side of a building is satisfactory. Location on a slight rise will avoid the danger of flooding. Locations on south slopes, depressions, or under the dripline of trees (fig. 1) should be avoided.

After being placed in the cache, it is very important that the trees not be disturbed until a day or two before planting.

Use of snow caches for "temporary" storage--when the trees are shifted from cache to cache as snowmelt proceeds to higher elevations--is not recommended. This practice almost invariably results in reduced survival and poor initial growth of survivors. Severe stresses are imposed on the trees by rapid and repeated temperature and humidity fluctuations and handling injuries.

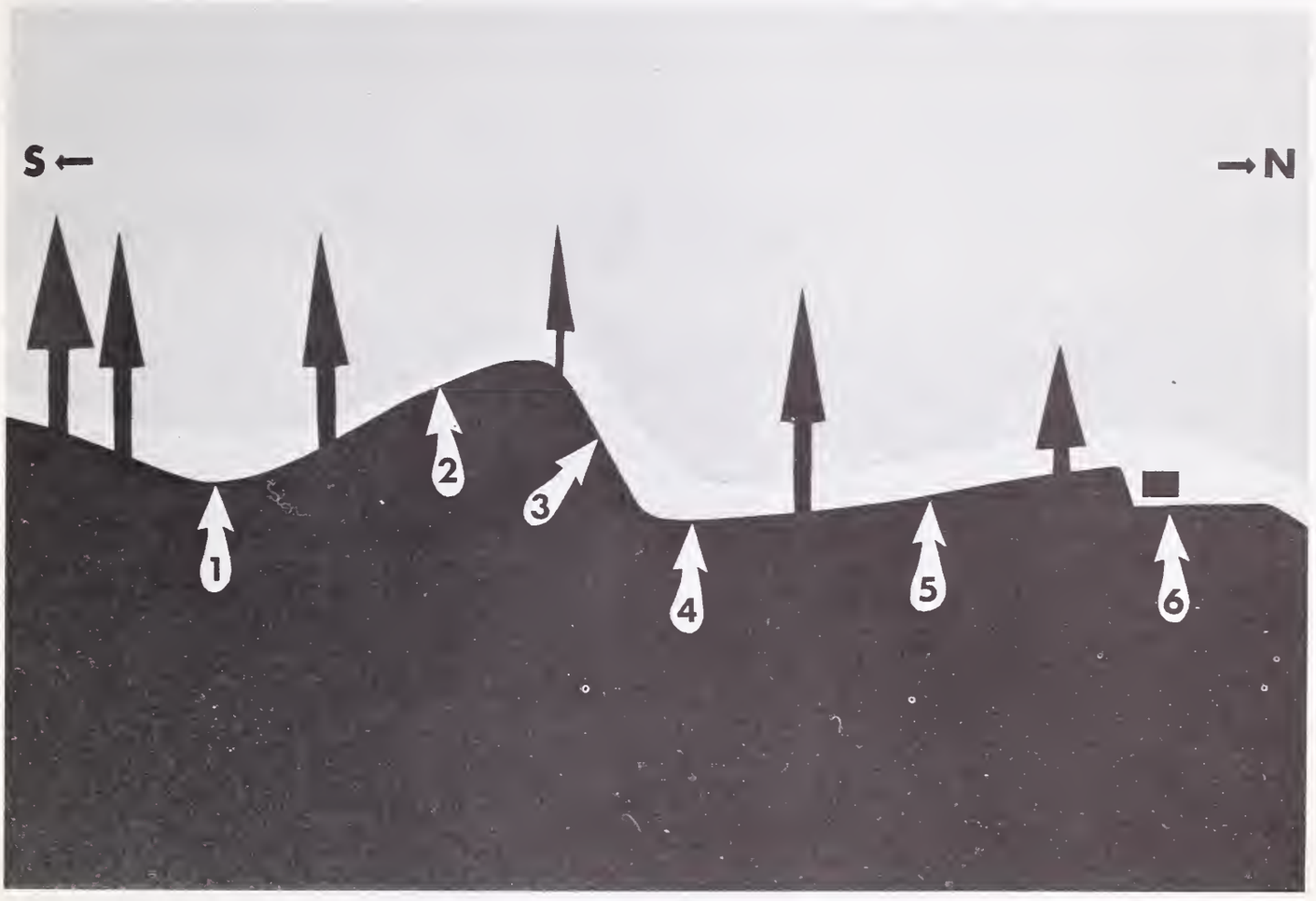

Figure 1.--Locating a snow cache.

Site 1...looks good, but could be bad. During periods of rapid snowmelt, water could accumulate in the low areas, inundating the trees.

Site 2...is on a rather steep south aspect. Snow accumulation is less, will melt early.

Site 3...is a long and very steep slope prone to snow creep or avalanche, which would dislocate the tree cache.

Site 4...is an acceptable location, particularly if an avalanche has already occurred on the adjacent slope.

Site 5...is a good location. Though it has a south aspect, the slope is not steep and there is shade from the existing stand. There is a good snowpack and good drainage.

Site 6...is ideal. In addition to having enough snow, shade, and good drainage, it is next to the road, facilitating the transportation of trees and the equipment to build the cache.

Preparatory work needed the fall before the cache is to be used varies. For a small cache, the only work necessary may be removing large debris from a fairly level area (approximately 1 square yard per thousand trees to be stored) and marking the exact cache location with long poles. Tractor work to clear and level the cache area, prepare turnarounds, and improve access may be required for a cache designed to hold several hundred thousand trees. Insulating material, other supplies, and tools may need to be placed near caches that will receive trees by airdrop or snowmobiles.

A sketch or plan should be made of the cache layout before construction or filling starts to assure that different lots of trees can be easily removed as needed. The plan should be followed closely when loading the cache and extracting the trees for planting to avoid unnecessary disturbance of the trees and conserve time and effort. All trees to be stored in a given cell or culvert section should arrive the same day.

Trees should be placed in snow caches as early in the spring as possible. This may require opening roads. Early cache construction reduces the chance of exposure damage to trees in handling, and assures an adequate volume of snow to bring the tree mass temperatures to the 33° to 34°F range and maintain them there as long as necessary. Snow is more easily worked before its water content is increased by accelerated melting late in the season, and snow lasts better when its water content is below 40 percent.

Close coordination is essential for satisfactory snow cache establishment. The nursery must schedule tree delivery to the cache area or transfer point by dependable truckers, and crews and equipment must be ready with adequate worktime scheduled to receive and store the trees. Poor scheduling may result in reduced survival and growth. Weather conditions must be considered if travel is in remote areas or where blizzard or avalanche conditions are present.

The number of trees to be stored, expected storage period, and snow cache location determine the amount and timing of work required for cache construction.

THE PIT SNOW CACHE

The storage cells in the pit snow cache should be shoveled or plowed out not more than a day or two before the trees are delivered. A level, firmly compacted snow floor no less than 2 feet thick should be provided. There should be no debris between the ground and the floor surface.

Tree packages should be stored in rows. The length of row needed for each lot of trees should be calculated and shown on the plan. Packages of trees should be stacked no more than four high. The rows of trees should be at least 1 foot apart, and the stacks of packages should be 6 inches apart in the rows to hasten cooling and provide circulation.

Cooling is improved and removal of seedlings made easier if two 2 by 4's are placed on edge between the third and fourth layers of packages as shown in figure 2. The timbers may be pulled free when the cache is opened, making it much easier to remove the packages.

Snow should be shoveled into the spaces between rows and stacks and over the top of the packages. Work of loading and shoveling crews should be coordinated on large projects to minimize exposure of the trees. The cache must be closed as soon after it is filled as possible.

Figure 2.--Arrangements of packages within a pit cache. There should be at least 2 feet of snow between the ground and the trees. Rows of tree packages should be at least 1 foot apart, and the stacks should be 6 inches apart within a row.

Kraft paper or cardboard box seedling packages may be protected from snowmelt by a single sheet of plastic over the top of the cell. The plastic should not extend down around the sides of the cell because this could reduce circulation and cause the trees to spoil.

A thick cover of snow can be dozed onto the cache when enough snow has been shoveled onto the trees to prevent the machine from crushing them. The entry to each cell of trees should be marked with long poles, and snow in this area should not be packed as tightly as in the main body of the cache. Entry will be difficult if the snow is packed hard at access points to be shoveled open in the spring. A powersaw may be used to facilitate cache opening.

A minimum of 4 feet of packed snow should be provided over the trees. The entire cache, and an area of snow surrounding the cache at least equal in width to the total height of the cache should be covered with a 4- to 6-inch layer of sawdust, straw, or shavings. A canvas or other water repellent covering should be placed over the completed cache to prevent rain from accelerating snowmelt (fig. 3).

Local experiences may indicate that larger masses of snow are needed if snow moisture content is high, available insulation materials are of low value, or if storage is to extend beyond mid-June. The snow cache needs no further attention except an occasional inspection to make sure the snow does not melt away in thin spots, and the covering is not removed.

A tarp should be hung over the opening of the cache after it has been opened to prevent heating within the cells (fig. 4).

Figure 3.--A completed cache with insulating material and protective covering in place. Properly located and constructed caches remain long after the snow on surrounding terrain has melted. This cache provided satisfactory seedling storage for 3-1/2 months, until mid-July.

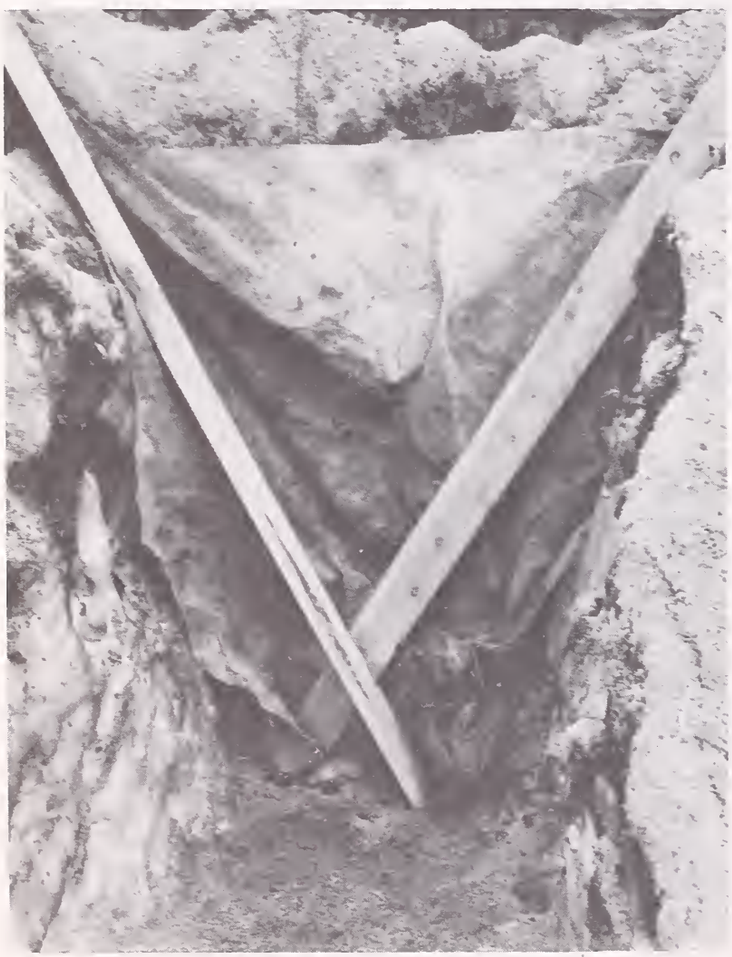

Figure 4.--An opened cache with tarp in place across the opening to prevent a temperature rise within the cache.

THE CULVERT SNOW CACHE

The culvert cache system offers several advantages over the pit snow cache. Expensive plowing through deep snow is not necessary, heavy equipment and large crews are not required, and trees can be stored economically at remote locations. Like the pit cache, the culvert cache is suitable for either large or small volumes of trees. It is not recommended for use with trees packaged in open crates since we have experienced serious drying when using this type of package in culverts. Tests are being made with perforated culverts in an effort to eliminate the drying problem. Good results have been obtained when trees in polyethylene-lined kraft paper bags have been stored in culvert pipes.

Suggested locations for culvert caches are heavy snowfall areas and sites where large drifts accumulate on level ground. Natural snow accumulation must be depended upon for cooling and temperature maintenance.

Pipe culverts to be used for caches must be placed the fall before use. Pipes 5 feet in diameter and up to 20 feet long are reasonably easy to handle and provide good storage and working space. The culvert should be positioned to 2 to 3 feet above the ground on logs or other supports to permit snow to accumulate under it and to prevent surface water seepage into the pipe. The pipe should be blocked up at intervals to prevent bending under the snow load. A system of stringers on log supports, spaced as needed to support anticipated snow loads, (fig. 5) has proven satisfactory.

The ends of the pipe should be marked with long poles to facilitate location in the spring. Insulating and covering materials should be stored in the pipe or nearby where they will be accessible when the snow is deep. A ladder is often useful for getting in and out of the culvert--especially in areas where snow depths range from 10 to 20 feet.

Tree packages can be transported to the storage site by snowmobiles or dropped from aircraft with cargo parachutes. A tree pickup crew equipped with snowmobiles must be on hand to retrieve air-dropped trees and transport them to the cache.

Tree placement in the culvert should provide for air circulation to maintain the desired temperatures. Pieces of 2 by 4's can be used to separate packages of trees in the culvert, or crude racks can be provided.

Entries to the pipe should be closed with snow immediately after the trees are stored, and the area above and around the culvert should be covered with protective materials as described for the pit snow cache. Snow may need to be shoveled over the culvert before insulation is applied if snow depth is marginal.

Other insulating materials may be available for retarding snowmelt, particularly where handling of bulk materials is difficult. Initial trials show that a "basket-weave" arrangement of fiberglass insulation rolls between two sheets of plastic can effectively slow snowmelt, and may be reused if handled carefully. Special care must be taken to assure that wind and gradual changes in the configuration of the snow mound do not cause the insulation to shift, permitting rapid snowmelt. A thick layer of tree boughs may be used as insulation if other materials are not available.

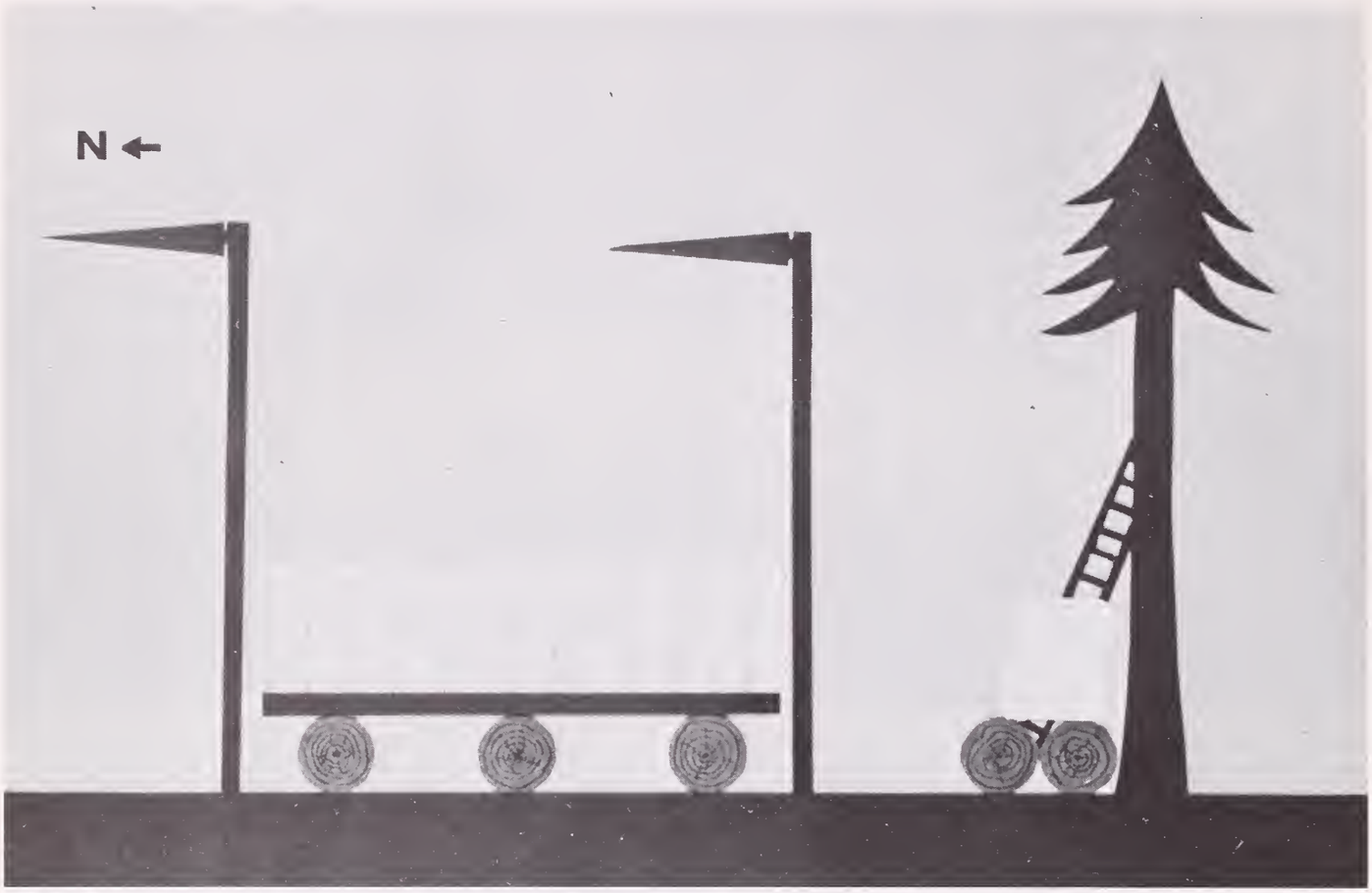

Figure 5.--A culvert pipe positioned 2 to 3 feet above the ground on log supports with stringers to prevent bending. Insulating and covering materials and an access ladder are placed nearby. Long poles with flagging mark each end of the pipe.

TREE HANDLING

Trees should be given a preshipping chill in the nursery cooler to reduce temperatures within the packages to 38°F or less. Trees should be kept refrigerated while in transit from the nursery to the snow caches. Temperature fluctuations in the tree packages while in transit to caches should be held to a minimum.

Temperatures of 50° to 75°F with relative humidities of 15 to 30 percent are common at planting sites in the Intermountain Region. Trees exposed to these conditions shortly after removal from the low temperature-high humidity environment of a snow cache are subjected to severe stresses. The most immediate and apparent response to this is wilting. Eventual responses may include premature needle drop, little or no bud elongation, or death, depending on the severity of the stress.

Correct handling and acclimatization to accustom the trees to the approximate atmospheric and soil conditions prevailing at the planting site will reduce or eliminate these problems, which are common in some degree to all other storage-handling systems.

Trees are considered acclimatized when root zone temperatures in the packages are at or near general soil temperature at a depth of 8 to 10 inches or air temperature, whichever is lowest. Soil thermometers with 12-inch temperature probes are ideal for measuring both soil and tree temperatures.

Trees may be acclimatized at any well-shaded, protected location convenient to both storage and planting areas. They must be covered while in transit, and should not be exposed to heat, sunlight, or drying winds until thoroughly acclimatized. After acclimatization, exposure should be held to a minimum until the trees are planted. Trees being acclimatized should be arranged with the tops exposed, to permit free, but gentle air movement around them. A tent or canvas fly is often used to control air movement. Surrounding areas should be kept moist to reduce stresses while the seedlings are adjusting to atmospheric conditions.

It is essential that an abundance of water be in close contact with the tree roots during the acclimatization period. Standard open-end crates contain an abundance of moist packing material that allows acclimatization before uncrating, but special handling is recommended. This special handling is required to acclimatize trees packed in bags or closed boxes. A satisfactory method is illustrated by figures 6 through 10.

The vermiculite dip-burlap wrapping method allows acclimatization to be completed and the trees to be transported to the planters with minimum stress. The nail must be removed and the burlap loosened slightly to permit easy tree removal when the package is placed in a planting bag or tray.

The time required for acclimatization depends on weather and other conditions at the planting site, but usually trees prepared in the afternoon are ready for planting the next morning. The trees should be in the ground within 12 to 24 hours and no longer than 48 hours after the start of the acclimatization process.

Figure 6.--Step 1: The roots of the trees, a handful at a time, are dipped into a thick slurry of #4 horticultural vermiculite. This coating of wet material clings to the roots, providing moisture and protection during periods of exposure until the trees are planted.

Figure 7.--Step 2: After dipping, an appropriate number of trees are placed on a 20- by 30-inch piece of wet burlap so their root collars are even with the long edge of the burlap and the roots are parallel to its short axis.

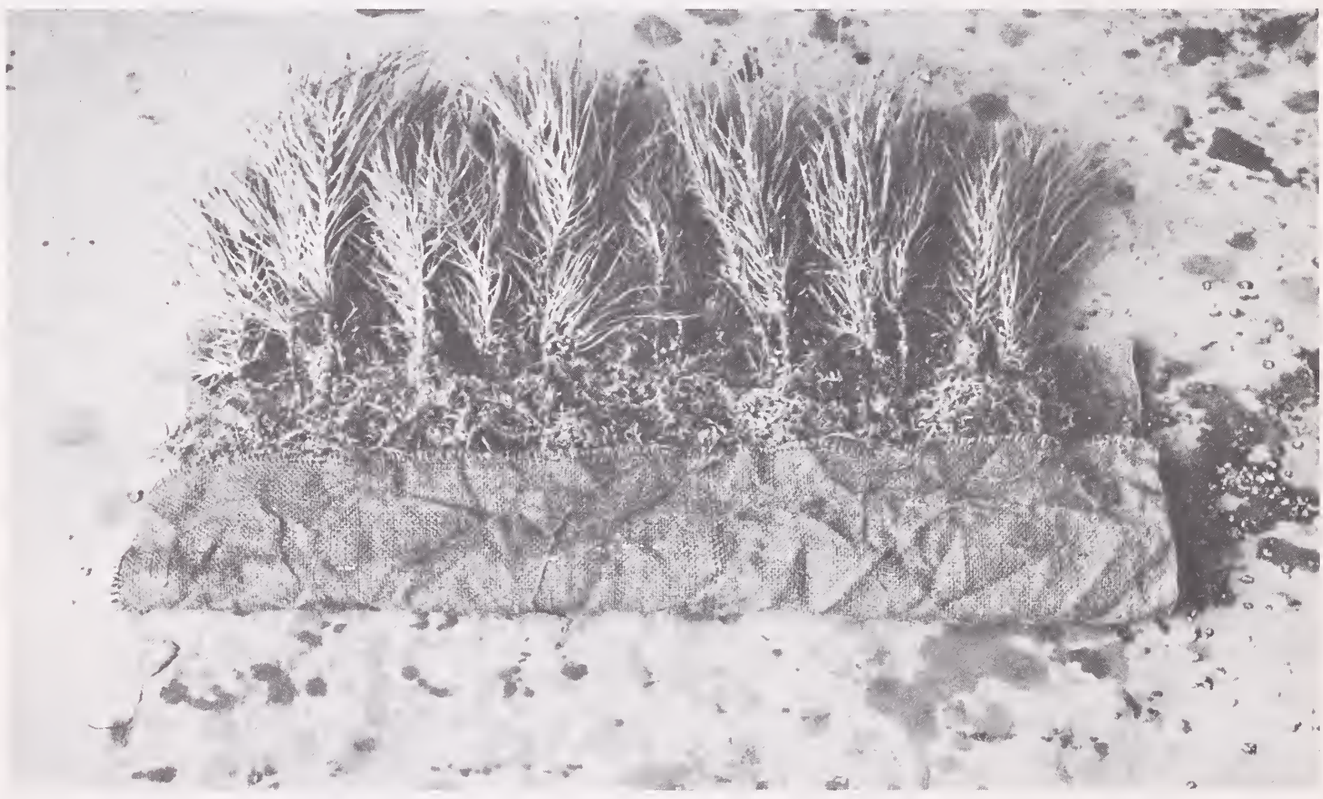

Figure 8.--Step 3: The burlap is then folded to cover the roots, taking care not to bend the roots into the fold.

Figure 9.--Step 4: Burlap and trees are then rolled firmly from one end to the other.

Figure 10.--Step 5: The outer end of the burlap is pinned in place with a 2-1/2-inch nail or other device.

SUMMARY

Properly constructed snow caches provide a good temperature and humidity regimen for storage of nursery stock.

The cache site should be convenient for the transportation to be used, should have adequate snow available when the trees arrive, and should be located where the snow will not melt too soon, making it necessary to disturb the trees again before planting.

Correct design of each storage compartment, or cell, assures the exclusion of harmful micro-organisms in the soil, and maintains the low temperatures needed to retard life processes of the trees and the development of any harmful organisms that might be present in the tree packages.

Construction in early spring favors accumulation of a large volume of snow of relatively low moisture content sufficient to promptly reduce and maintain temperatures just above freezing for an extended period.

Appropriate insulation will assure retention of an adequate snow mass through midsummer in most areas.

Correct handling and acclimatization of the trees to the atmospheric and soil conditions prevailing on the planting site minimize stress and increase survival and first-year growth of newly planted trees.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974 — 677-090 / 21 REGION NO. 8

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